ISSN 0097-4463

ANNALS of CARNEGIE MUSEUM

CARNEGIE MUSEUM OF NATURAL HISTORY

4400 FORBES AVENUE • PITTSBURGH, PENNSYLVANIA 15213

VOLUME 52 | 16 SEPTEMBER 1983 | ARTICLE 15

TAXONOMIC REVIEW OF TEMMINCK'S TRIDENT BAT, *ASELLISCUS TRICUSPIDATUS* (TEMMINCK, 1834) (MAMMALIA: HIPPOSIDERIDAE)

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Abstract

Specimens of Temminck's trident bat (*Aselliscus tricuspidatus*) from Australasia were analyzed for morphological variation. Univariate and multivariate analyses were used to determine individual, secondary sexual, and geographic variation within the species. Individual variation was greater in females than in males although this variation generally was minor in all cases. Females were found to be significantly larger than males in four of seven measurements tested. The analysis of geographic variation revealed that four subspecies can be recognized within the species; two of these are described as new.

Introduction

Two species of trident bats are currently recognized in the genus *Aselliscus* (Corbet and Hill, 1980:52). Temminck's trident bat, *Aselliscus tricuspidatus* (Temminck, 1834), is known from Buru and Batjan islands in the Moluccas eastward through New Guinea and the Solomons as far as Espiritu Santo Island in the New Hebrides (Laurie and Hill, 1954:62). The second species in the genus, *Aselliscus stoliczkanus* (Dobson, 1871), occurs from Burma and southern China southward

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Submitted 14 April 1983.

through southeastern Asia as far as Penang Island in peninsular Malaysia.

Aselliscus tricuspidatus (Temminck, 1834) was proposed for a female specimen collected by Muller and Macklot from Ambon Island, Moluccas. A subspecies, *A. t. novehebridensis,* was described by Sanborn and Nicholson (1950:331) based on specimens from Espiritu Santo Island, New Hebrides, at the eastern limits of the range of the species.

Although few specimens are available from some areas within the known range of the species, enough specimens are available at this time to review the taxonomy of the species. The objectives of the study were to analyze nongeographic and geographic variation within the species, and then to assess the taxonomic significance of the variation.

Materials and Methods

A total of 211 specimens of *Aselliscus tricuspidatus* were examined. Only adults were used for statistical comparisons; these were so judged by the complete fusion of the epiphyseal phalanges and of the sutures in the basioccipital-basisphenoidal region of the skull. Conventional standard external measurements, when given, were recorded from the specimen label. Forearm and cranial measurements were taken with dial calipers.

One external and six cranial measurements were selected for comparison and are given in millimeters. Measurements are defined below.

Length of forearm.—Greatest distance from posterior extremity of the olecranon process of the ulna to the distal extremity of the carpals.

Condylocanine length.—Greatest distance from posterior portion of occipital condyles to anteriormost edge of canines.

Zygomatic breadth.—Greatest width across zygomatic arches, measured at right angle to longitudinal axis of cranium.

Postorbital constriction.—Least width across constriction posterior to orbits, measured at right angle to longitudinal axis of cranium.

Mastoidal breadth.—Greatest width across mastoidal processes, measured at right angle to longitudinal axis of cranium.

Length of maxillary toothrow.—Least distance from anterior lip of alveolus of C^1 to posterior lip of alveolus of M^3.

Breadth across upper molars.—Least distance, measured at right angle to longitudinal axis of cranium, from labial side of respective crowns of M^3 of each toothrow.

Localities from which specimens were examined were grouped into 13 geographical samples for analyses of data. These samples (identified by number, see Fig. 1), with the localities included in each group, are as follows: 1) Indonesia: Buru; 2) Indonesia: Ambon, Seram, and Gorong Islands; 3) Indonesia: Kai Islands; 4) Indonesia: Misor Islands and Yapen Island; 5) Indonesia: Irian Jaya: Hollandia and south side Humboldt Bay; 6) Papua New Guinea: Kaiseren Augusta River; Ama; 7) Papua New Guinea: Madang; 8) Papua New Guinea: Woodlark Island; Misima Island; and Kiriwina Island; 9) Solomon Islands: Russell Islands; New Georgia Island; San Jorge Island; and Guadalcanal; 10) Solomon Islands: Rennell Island; 11) Solomon Islands: San Cristobal Island and Uki Ni Masi; 12) Santa Cruz Island; 13) New Hebrides: Espiritu Santo Island.

Univariate analyses of secondary sexual variation and individual variation were performed using the UNIVAR program developed and introduced by Power (1970). Standard statistics (mean, range, standard deviation, standard error, variance, and coefficient of variation) are generated by this program. A single classification analysis of variance (ANOVA; F-test, significance level 0.05) was employed to test for significant differences

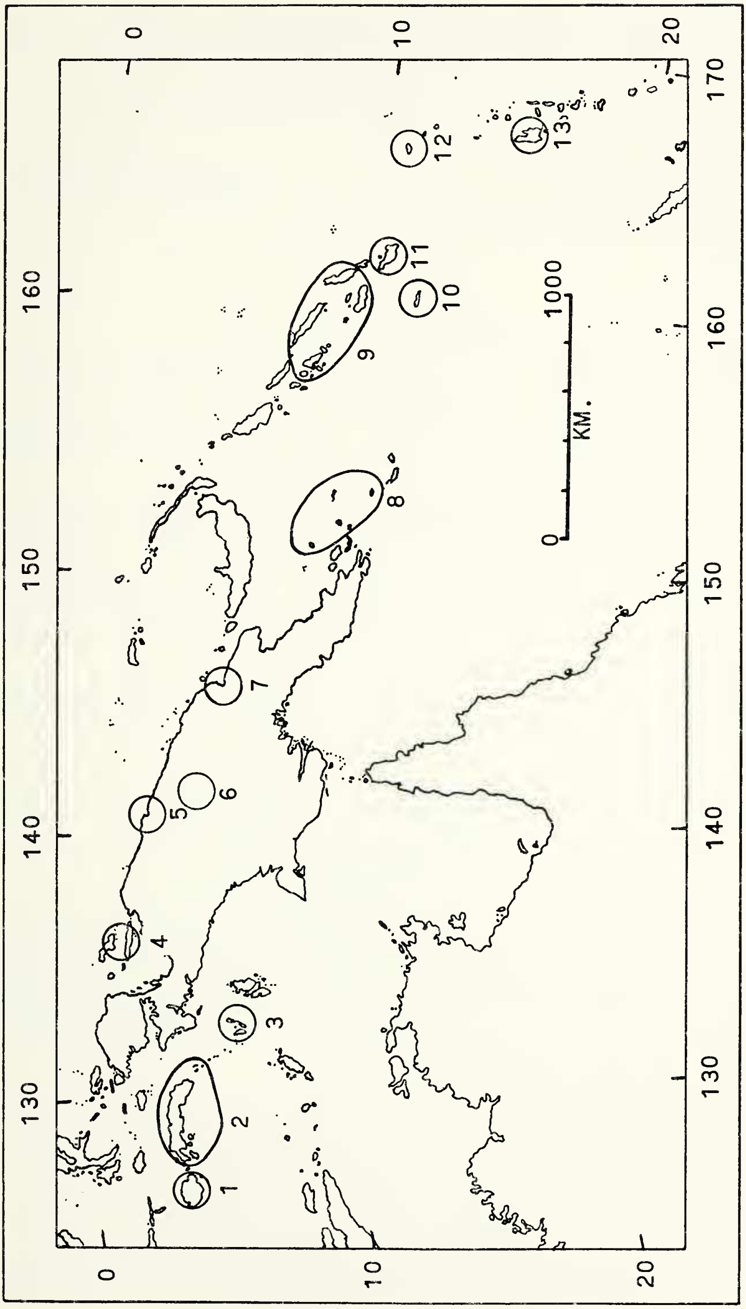

Fig. 1.—Geographic areas included in the 13 geographic samples of *Aselliscus tricuspidatus*. See Materials and Methods section of text for list of localities included in each sample.

between or among means (Sokal and Rohlf, 1969). When means were found to be significantly different, the Sums of Squares Simultaneous Test Procedure (SS-STP) determined the maximally nonsignificant subsets.

Stepwise discriminant analysis and canonical analysis (BMDP7M, Dixon and Brown, 1977) perform a multiple discriminant analysis in a stepwise fashion, selecting the variable entered by finding the variable with the greatest F value. The F value for inclusion was set at 0.01, and the F value for deletion was set at 0.05. Canonical coefficients were derived by multiplying the coefficient of each discriminant function by the mean of each corresponding variable. The program also classifies individuals by placing them with the group that they are nearest to on the discriminant functions.

RESULTS

Nongeographic Variation

Using a single classification analysis of variance, individual and secondary sexual variations were examined in a single sample of *Aselliscus tricuspidatus* from the vicinity of Hollandia, Dutch New Guinea [=Jayapura, Irian Jaya, Indonesia] (Table 1). Age variation was not considered because only adults were available for study.

Individual variation.—Coefficients of variation (CV) of one external and six cranial measurements are represented in Table 1. CVs ranged from 1.05 (mastoidal breadth of females) to 5.45 (postorbital constriction of females). Both CVs for postorbital constriction were above 5 (5.19 in males) whereas the next highest CV was 2.47 for length of maxillary toothrow of females.

Coefficients of variation are listed in Table 2 for additional geographic samples of males and females. These values generally match the low values listed in Table 1. Among the geographic samples of males, only postorbital constriction shows a high CV value. In the geographic samples of females, again the postorbital constriction exhibits high CV values. In addition, OTU 2 has high CV values for length of forearm and breadth across upper molars while OTU 4 has a high CV value for mastoidal breadth and OTU 9 has a high value for length of maxillary toothrow. Other than postorbital constriction, which was the smallest measurement taken, coefficients of variation for all of the measurements in this study were generally low and in accordance with similar measurements of previous studies of bats (Long, 1968; Hayward, 1970; Smith, 1972; Davis, 1973; Swanepoel and Genoways, 1979; Martin and Schmidly, 1982).

Secondary sexual variation.—Based upon the results of a single classification analysis of variance between males and females from Hollandia, Irian Jaya, females were found to be significantly larger than males in four of the seven measurements tested for secondary sexual variation (Table 1). The length of maxillary toothrow showed the highest value for significant differences between the two sexes. In two of the remaining three measurements, females averaged larger than males.

Table 1.—*Nongeographic variation in selected external and cranial measurements of 15 females and 12 males of* Aselliscus tricuspidatus *from the vicinity of Jayapura, Irian Jaya, Indonesia [=Hollandia, Dutch New Guinea]. Statistics given are mean, two standard errors of the mean, range, coefficient of variation, F-value, and critical F-value (lower value). Means that were found to be not significantly different at the 5 per cent level are marked* ns.

Sex	Mean ± 2 SE	Range	CV	Fs/F
		Length of forearm		
Female	42.19 ± 0.42	41.0–43.3	1.93	6.85
Male	41.29 ± 0.56	39.2–42.6	2.33	4.24
		Condylocanine length		
Female	13.19 ± 0.08	13.0–13.4	1.11	4.57
Male	13.04 ± 0.12	12.8–13.5	1.58	4.24
		Zygomatic breadth		
Female	7.63 ± 0.07	7.3–7.8	1.68	*ns*
Male	7.56 ± 0.08	7.3–7.8	1.74	
		Postorbital constriction		
Female	1.95 ± 0.05	1.7–2.1	5.45	*ns*
Male	1.98 ± 0.06	1.8–2.2	5.19	
		Mastoidal breadth		
Female	7.04 ± 0.04	6.9–7.2	1.05	*ns*
Male	6.98 ± 0.07	6.8–7.2	1.63	
		Length of maxillary toothrow		
Female	5.05 ± 0.06	4.8–5.2	2.47	15.20
Male	4.89 ± 0.05	4.8–5.1	1.62	4.24
		Breadth across upper molars		
Female	5.30 ± 0.06	5.0–5.4	2.26	6.76
Male	5.19 ± 0.05	5.0–5.3	1.73	4.24

In no instance were males significantly larger than females. Thus because females are significantly larger than males in some measurements, samples of males and females were kept separate for the purpose of analyzing geographic variation.

Geographic Variation

Univariate and multivariate analyses were performed to compare the geographic samples in order to establish the relationships among the populations studied. Specimens of *Aselliscus tricuspidatus* were grouped into 13 geographic samples (OTUs) separated by sexes, for the analysis of geographic variation (for localities included in each geographic sample, see Materials and Methods section and Fig. 1). No females were available for geographic samples 12 and 13.

Univariate analyses.—Geographic samples of three or more individuals were entered in the Sum of Squares Simultaneous Test Procedure (SS-STP) to determine the maximally nonsignificant subsets between and among means of each variable for the geographic samples. Table 2 gives standard statistics for the seven variables from the 13 geographic samples. Table 3 lists a series of means with maximally nonsignificant subsets of the seven variables in order to demonstrate trends in geographic variation.

Results of the univariate analyses of geographic variation indicate that the New Hebrides sample (OTU 13) is characterized by individuals of large size for the species. Individuals from mainland New Guinea (OTUs 4–7) are slightly smaller in most variables than those from New Hebrides. Two geographical groups of OTUs are characterized by small individuals, namely the samples from the Moluccas (OTUs 1–3) and the East Papuan islands and the Solomons (OTUs 8–11). Individuals from Santa Cruz (OTU 12) are small but tend in some measurements to be as large as individuals from New Hebrides.

Patterns of geographic variation indicate that the New Hebrides sample (OTU 13) is large for measurements of length of forearm, condylocanine length, zygomatic breadth and breadth across upper molars. The New Guinea mainland group (OTUs 4–7) is large for the measurements of length of forearm, condylocanine length (especially in females), zygomatic breadth, and breadth across upper molars. The western group (OTUs 1–3 from the Moluccas) show small size for the measurements of condylocanine length, postorbital constriction, mastoidal breadth, and breadth across molars. This group exhibits relatively large size for length of maxillary toothrow in males. Except for postorbital constriction, the samples from the East Papuan islands and the Solomons (OTUs 8–11) exhibit small size in all measurements, especially in condylocanine length, zygomatic breadth, mastoidal breadth, and breadth across upper molars in both sexes.

Multivariate analyses.—Canonical analyses provide a procedure for graphically representing phenetic relationship among samples with the morphometric characters weighted by variance-covariance analysis. The two-dimensional plots of the male and female samples of *Aselliscus tricuspidatus* are presented in Fig. 2. In the males, small individuals are separated to the right on the first variate as two groups. The Moluccan samples (OTUs 1–3) and the East Papuan island sample (OTU 8) and the Solomon Islands samples (OTUs 9 and 11) are grouped together. In the center, the Santa Cruz Island sample (OTU 12) is grouped with the samples from Misor and Yapen islands of northeast New Guinea (OTU 4) and the mainland New Guinea individuals (OTUs 5 and 7). On the left are the large individuals from New Hebrides (OTU 13). The Sepik River sample (OTU 6) is separated on Variate II on

Table 2.—*Geographic variation in selected external and cranial measurements of samples of males followed by females of* Aselliscus tricuspidatus. *Statistics given are sample size, mean, two standard errors of the mean, range, and coefficient of variation. Means only are listed for samples of less than four individuals. See Fig. 1 and text for key to locality numbers and definition of measurements. No data for zygomatic breadth of males are available for locality 10.*

Locality	N	Mean ± 2 SE	Range	CV
		MALES		
		Length of forearm		
1	2	39.8, 38.6		
2	6	39.7 ± 0.78	38.8–41.2	2.40
3	2	38.1, 37.8		
4	1	41.4		
5	12	41.3 ± 0.56	39.2–42.6	2.33
6	1	40.4		
7	4	41.3 ± 1.33	39.6–42.6	3.23
8	15	39.2 ± 0.34	37.4–40.1	1.66
9	2	39.3, 37.5		
10	2	39.3, 37.6		
11	11	39.4 ± 0.50	37.7–40.5	2.11
12	3	39.0, 39.1, 37.4		
13	2	41.5, 40.3		
		Condylocanine length		
1	3	12.3, 12.3, 12.7		
2	6	12.6 ± 0.96	12.4–12.7	0.96
3	2	12.2, 12.1		
4	1	13.3		
5	12	13.0 ± 0.12	12.8–13.5	1.58
6	1	13.0		
7	4	13.1 ± 0.17	12.9–13.3	1.31
8	16	12.4 ± 0.08	12.1–12.7	1.34
9	2	12.4, 12.3		
10	2	12.4, 12.1		
11	10	12.5 ± 0.12	12.2–12.7	1.46
12	2	13.2, 12.3		
13	2	13.5, 13.2		
		Zygomatic breadth		
1	2	7.0, 6.9		
2	5	6.8 ± 0.14	6.6–7.0	2.22
3	2	7.1, 7.0		
4	1	7.9		
5	12	7.6 ± 0.08	7.3–7.8	1.74
6	1	7.7		
7	4	7.6 ± 0.17	7.4–7.8	2.24
8	6	7.1 ± 0.10	6.9–7.2	1.71
9	2	7.0, 6.8		
11	10	7.1 ± 0.09	6.8–7.3	2.08
12	2	6.7, 7.6		
13	2	8.0, 7.8		

Table 2.—*Continued.*

Locality	N	Mean ± 2 SE	Range	CV
		Postorbital constriction		
1	3	1.7, 1.7, 1.7		
2	6	1.6 ± 0.10	1.5–1.8	7.41
3	2	1.9, 2.0		
4	1	2.2		
5	12	2.0 ± 0.06	1.8–2.2	5.19
6	1	1.8		
7	4	1.9 ± 0.10	1.8–2.0	4.97
8	17	1.9 ± 0.04	1.8–2.1	3.92
9	2	1.9, 1.7		
10	2	2.0, 2.0		
11	10	2.0 ± 0.03	1.9–2.0	2.70
12	3	1.5, 1.9, 1.8		
13	2	1.7, 1.8		
		Mastoidal breadth		
1	3	6.4, 6.4, 6.6		
2	5	6.7 ± 0.19	6.4–6.9	3.11
3	2	6.6, 6.5		
4	1	7.2		
5	12	7.0 ± 0.07	6.8–7.2	1.63
6	1	6.9		
7	4	7.0 ± 0.13	6.8–7.1	1.80
8	16	6.6 ± 0.09	6.1–6.8	2.75
9	2	6.7, 6.6		
10	2	6.8, 6.3		
11	10	6.6 ± 0.07	6.4–6.7	1.56
12	3	6.6, 7.0, 6.8		
13	2	7.0, 6.9		
		Length of maxillary toothrow		
1	3	4.9, 4.9, 5.0		
2	6	5.0 ± 0.08	4.8–5.1	2.08
3	2	4.8, 4.8		
4	1	5.2		
5	12	4.9 ± 0.05	4.8–5.1	1.62
6	1	5.5		
7	4	5.1 ± 0.00	5.1	0.00
8	17	4.8 ± 0.04	4.7–5.0	1.69
9	2	4.8, 4.8		
10	2	4.9, 4.8		
11	11	4.9 ± 0.06	4.7–5.0	1.92
12	2	5.0, 5.2		
13	2	5.2, 5.2		
		Breadth across upper molars		
1	2	4.9, 4.9		
2	6	4.9 ± 0.10	4.7–5.0	2.38
3	2	4.9, 4.9		
4	1	5.4		

Table 2.—*Continued.*

Locality	N	Mean ± 2 SE	Range	CV
5	12	5.2 ± 0.05	5.0–5.3	1.73
6	1	5.3		
7	4	5.3 ± 0.10	5.2–5.4	1.82
8	17	4.9 ± 0.05	4.7–5.1	2.10
9	2	5.0, 4.8		
10	2	5.0, 4.8		
11	11	4.9 ± 0.08	4.7–5.1	2.58
12	3	4.6, 5.4, 4.8		
13	2	5.5, 5.5		
		FEMALES		
		Length of forearm		
1	1	40.5		
2	3	39.8 ± 2.26	38.2–42.0	4.91
3	1	39.2		
4	3	41.6 ± 1.22	40.4–42.4	2.54
5	15	42.2 ± 0.42	41.0–43.3	1.93
6	2	42.6, 41.3		
7	2	42.1, 42.3		
8	7	39.8 ± 0.40	38.9–40.4	1.33
9	4	39.2 ± 0.80	38.5–40.1	2.03
10	2	38.4, 38.4		
11	9	39.4 ± 0.54	38.7–40.9	2.05
		Condylocanine length		
1	1	12.8		
2	3	12.5 ± 0.23	12.3–12.7	1.60
3	1	12.7		
4	3	13.3 ± 0.40	12.9–13.5	2.60
5	15	13.2 ± 0.08	13.0–13.4	1.11
6	2	13.5, 13.5		
7	2	13.0, 13.1		
8	8	12.5 ± 0.08	12.4–12.7	0.85
9	4	12.5 ± 0.25	12.2–12.8	2.00
10	2	12.4, 12.1		
11	9	12.4 ± 0.07	12.2–12.5	0.88
		Zygomatic breadth		
1	1	7.0		
2	3	7.0 ± 0.13	6.9–7.1	1.66
3	1	7.1		
4	3	7.5 ± 0.24	7.3–7.7	2.76
5	15	7.6 ± 0.07	7.3–7.8	1.68
6	2	7.5, 8.0		
7	2	7.6, 7.6		
8	2	7.0, 7.1		
9	4	7.0 ± 0.13	6.8–7.1	1.80
10	1	7.0		
11	9	7.0 ± 0.07	6.9–7.2	1.50

Table 2.—*Continued.*

Locality	N	Mean ± 2 SE	Range	CV
		Postorbital constriction		
1	1	1.9		
2	3	1.7 ± 0.18	1.5–1.8	9.17
3	1	2.1		
4	3	1.8 ± 0.13	1.7–1.9	6.30
5	15	2.0 ± 0.05	1.7–2.1	5.45
6	2	2.0, 2.2		
7	2	2.0, 1.9		
8	8	1.9 ± 0.05	1.8–2.0	3.35
9	4	1.8 ± 0.14	1.7–2.0	7.86
10	2	2.0, 1.8		
11	9	1.9 ± 0.06	1.8–2.1	4.34
		Mastoidal breadth		
1	1	6.5		
2	3	6.7 ± 0.07	6.6–6.7	0.87
3	1	6.7		
4	3	7.3 ± 0.48	6.8–7.6	5.73
5	15	7.0 ± 0.04	6.9–7.2	1.05
6	2	7.1, 7.3		
7	2	6.9, 7.1		
8	8	6.7 ± 0.06	6.5–6.8	1.38
9	4	6.6 ± 0.15	6.5–6.8	2.28
10	2	6.6, 6.5		
11	9	6.5 ± 0.07	6.5–6.8	1.55
		Length of maxillary toothrow		
1	1	5.0		
2	3	4.8 ± 0.07	4.8–4.9	1.19
3	1	5.0		
4	3	5.2 ± 0.07	5.1–5.2	1.12
5	15	5.1 ± 0.06	4.8–5.2	2.47
6	2	5.1, 5.0		
7	2	5.1, 5.1		
8	8	4.8 ± 0.05	4.7–4.9	1.54
9	4	4.9 ± 0.22	4.6–5.1	4.55
10	2	4.9, 4.7		
11	9	4.8 ± 0.06	4.6–4.9	1.93
		Breadth across upper molars		
1	1	4.9		
2	3	5.0 ± 0.23	4.8–5.2	4.00
3	1	4.8		
4	3	5.3 ± 0.12	5.2–5.4	1.89
5	15	5.3 ± 0.06	5.0–5.4	2.26
6	2	5.3, 5.4		
7	2	5.4, 5.3		
8	8	4.9 ± 0.05	4.8–5.0	1.54
9	4	4.9 ± 0.05	4.8–4.9	1.03
10	2	4.8, 4.7		
11	8	4.8 ± 0.11	4.6–5.0	3.34

Table 3.—*Results of seven SS-STP analyses of geographic variation in samples of males followed by females of* Aselliscus tricuspidatus. *Vertical lines to the right of each series of means connect maximally nonsignificant subsets at the 0.05 level of significance. See Fig. 1 and text for key to geographic samples included in each locality number and definitions of measurements.*

Males					Females				
Locality	Mean	Results SS-STP			Locality	Mean	Results SS-STP		
Length of forearm									
5	41.3	|			5	42.2	|		
7	41.3	|	|		4	41.6	|	|	
2	39.7		|	|	8	39.8		|	|
11	39.4			|	2	39.8		|	|
8	39.2			|	11	39.4			|
					9	39.2			|
Condylocanine length									
7	13.1	|			4	13.3	|		
5	13.0	|			5	13.2	|		
2	12.6		|		8	12.5		|	
11	12.5		|		9	12.5		|	
8	12.4		|		2	12.5		|	
					11	12.4		|	
Zygomatic breadth									
7	7.6	|			5	7.6	|		
5	7.6	|			4	7.5	|		
11	7.1		|		11	7.0		|	
8	7.1		|	|	9	7.0		|	
2	6.8			|	2	7.0		|	
Postorbital constriction									
5	2.0	|			5	2.0	|		
11	2.0	|			11	1.9	|		
7	1.9	|			8	1.9	|		
8	1.9	|			4	1.8	|	|	
2	1.6		|		9	1.8	|	|	
					2	1.7		|	
Mastoidal breadth									
7	7.0	|			4	7.3	|		
5	7.0	|			5	7.0	|		
2	6.7		|		2	6.7		|	
11	6.6		|		8	6.7		|	
8	6.6		|		9	6.6		|	
					11	6.5		|	
Length of maxillary toothrow									
7	5.1	|			4	5.2	|		
2	5.0	|	|		5	5.1	|		
11	4.9		|		9	4.9	|	|	
5	4.9		|		8	4.8		|	
8	4.8			|	2	4.8		|	
					11	4.8		|	

Table 3.—*Continued.*

Males				Females			
Locality	Mean	Results SS-STP		Locality	Mean	Results SS-STP	
Breadth across upper molars							
7	5.3	│		4	5.3	│	
5	5.2	│		5	5.3	│	
11	4.9		│	2	5.0		│
2	4.9		│	8	4.9		│
8	4.9		│	9	4.9		│
				11	4.8		│

the upper left from the rest of the mainland New Guinea samples in the center of the plot. In the females, most of the separation can be accounted for on the first variate. Two groups are present in the plot of females. The mainland New Guinea samples, including the Misor and Yapen islands sample, are represented by OTUs 4–7 on the left of the plot. The right of the plot includes two geographic groups. The Moluccan samples are represented by OTUs 1–3 although the three geographic samples are separated somewhat by Variate II. The samples from the East Papuan islands and the Solomon Islands are grouped on the left on Variate I. OTU 9 is separated from the other samples on Variate II.

The amount of total dispersion accounted for in the male and female samples, respectively, was 50.8 and 79.3% for Variate I, and 36.7 and 11.5% for Variate II. The total dispersion accounted for on the first two axes for male and female samples, respectively, was 87.5 and 90.8%.

Morphometric characters used in this analysis are listed in Table 4, from the most useful to the least useful in discriminating groups. For males, zygomatic breadth, mastoidal breadth, and breadth across upper molars have the strongest influence in separating those samples on the first variate of the discriminant projection plot of Fig. 2. The length of maxillary toothrow separates OTU 6 from the remaining groups while the length of postorbital constriction predominantly separates the groups in the lower right of the projection plot. Condylocanine length separates those groups in the lower left of the projection plot. In females, all seven variables equally separate the two major groups on the first variate while zygomatic breadth and postorbital constriction have a positive effort on Variate II.

The classification matrix for males and females of *Aselliscus tri-*

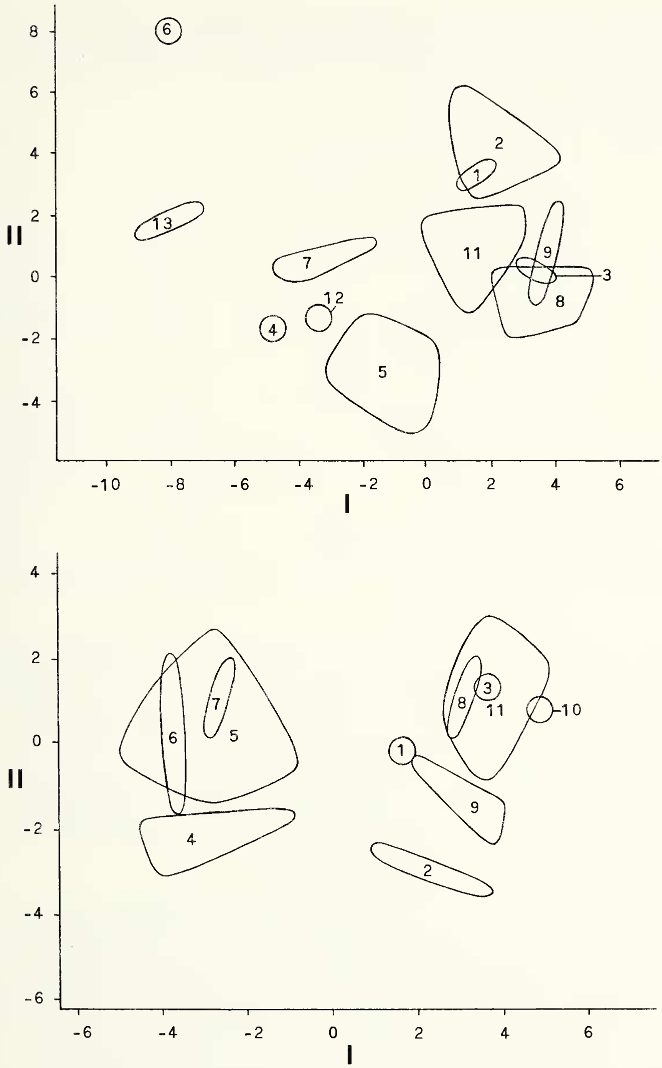

Fig. 2.—Two-dimensional projection of the first two canonical variates of male (upper) and female (lower) geographic samples of *Aselliscus tricuspidatus,* based on a classification of variance-covariance among one external and six cranial measurements.

Table 4.—*Variables used in discriminant function analyses of males and females of* Aselliscus tricuspidatus. *Characters are listed in order of their usefulness in distinguishing groups, with the character with the greatest between-groups variance and the least within-groups variance being selected first. The statistics are recalculated at each step.*

Step	Character	F-value	U-statistic
	Males		
1	Zygomatic breadth	25.47	0.1054
2	Length of maxillary toothrow	13.06	0.0192
3	Postorbital constriction	6.76	0.0056
4	Mastoidal breadth	3.63	0.0024
5	Condylocanine length	2.13	0.0013
6	Length of forearm	1.41	0.0009
7	Breadth across upper molars	0.47	0.0007
	Females		
1	Condylocanine length	21.70	0.1250
2	Postorbital constriction	3.68	0.0562
3	Zygomatic breadth	2.70	0.0291
4	Length of forearm	1.86	0.0175
5	Mastoidal breadth	1.67	0.0108
6	Breadth across upper molars	0.87	0.0081
7	Length of maxillary toothrow	0.95	0.0059

cuspidatus analysed in the canonical analysis is given in Table 5. All females were correctly classified for each geographical sample. For males, two individuals from the vicinity of Hollandia and Humboldt Bay were placed with the Sepik River sample while five were classified with the Madang sample. A single male from the Solomon Islands sample was placed with the Kai Island sample, both groups being generally small in size. A single male from San Cristobal Island was classified with the Rennell Island sample.

The geographic variation found in *A. tricuspidatus* is almost exclusively metrical in nature, with variation occurring between different islands and island groups. There exists overlap in dimensional features between populations from widely separated islands or between islands that differ sharply in size, in the latter case probably directly reflecting the size of the population that the island can support. Although color of pelage was checked in the various geographic samples studied, no discernable geographic variation in pelage color was noted even though individual variation from yellowish brown to orange and even reddish color was recorded.

Taxonomic Conclusions

Based upon our interpretations of the univariate and multivariate analyses, we found that *Aselliscus tricuspidatus* can be divided into four

Table 5.—*Classification matrix for male and female samples of* Aselliscus tricuspidatus, *based upon the discriminant functions of seven morphometric characters. Values indicate the number of individuals classified into each group. Sample 10 and samples 12 and 13 are unrepresented in the male and female classification matrices, respectively.*

	Classification groups												
Sample	1	2	3	4	5	6	7	8	9	10	11	12	13
Males													
1) Buru	2	0	0	0	0	0	0	0	0		0	0	0
2) Anbon and Seram	0	5	0	0	0	0	0	0	0		0	0	0
3) Kai I.	0	0	2	0	0	0	0	0	0		0	0	0
4) Misor and Yapen	0	0	0	1	0	0	0	0	0		0	0	0
5) Humboldt Bay	0	0	0	0	12	0	0	0	0		0	0	0
6) Sepic River	0	0	0	0	0	1	0	0	0		0	0	0
7) Madang	0	0	0	0	0	0	4	0	0		0	0	0
8) East Papuan Is.	0	0	0	0	0	0	0	5	0		0	0	0
9) Solomon Is.	0	0	0	0	0	0	0	0	2		0	0	0
11) San Cristobal I.	0	0	0	0	0	0	0	0	0		8	0	0
12) Santa Cruz	0	0	0	0	0	0	0	0	0		0	1	0
13) New Hebrides	0	0	0	0	0	0	0	0	0		0	0	2
Females													
1) Buru	1	0	0	0	0	0	0	0	0	0	0		
2) Ambon and Seram	0	3	0	0	0	0	0	0	0	0	0		
3) Kai I.	0	0	1	0	0	0	0	0	0	0	0		
4) Misor and Yapen	0	0	0	3	0	0	0	0	0	0	0		
5) Humboldt Bay	0	0	0	0	8	2	5	0	0	0	0		
6) Sepic River	0	0	0	0	0	2	0	0	0	0	0		
7) Madang	0	0	0	0	0	0	2	0	0	0	0		
8) East Papuan Is.	0	0	0	0	0	0	0	2	0	0	0		
9) Solomon Is.	0	1	0	0	0	0	0	0	3	0	0		
10) Rennell I.	0	0	0	0	0	0	0	0	0	1	0		
11) San Cristobal I.	0	0	0	0	0	0	0	0	0	1	7		

distinct geographic groups based upon size. The largest size for the species is found in individuals from New Hebrides. Slightly smaller in size are individuals from the New Guinea mainland and Misor and Yapen islands. Individuals from the Moluccas and from the islands east of the mainland of New Guinea as far east as Santa Cruz Island are among the smallest in size. Although the individuals from Santa Cruz Island approach the New Hebrides sample in size in certain measurements, they are nonetheless nearer to the populations immediately to the west.

The samples from the Moluccas are referrable to *A. t. tricuspidatus*; those from New Hebrides to *Aselliscus tricuspidatus novehebridensis* Sanborn and Nicholson, 1950. The remaining two geographic groups are described as new subspecies in the following accounts.

ACCOUNTS OF SUBSPECIES

Aselliscus tricuspidatus tricuspidatus (Temminck, 1834)

1834. *Rhinolophus tricuspidatus* Temminck, Tijdschr. Natuurk. Gesch., 1(1):20, pl. 1, fig. 4.
1871. *Phyllorhina tricuspidata,* Peters, Monats. K. Preuss. Akad. Wissensch., Berlin, p. 314.
1904. *Hipposiderus tricuspidata,* Trouessart, Cat. Mamm., Suppl., p. 70.
1941. *Aselliscus tricuspidatus,* Tate, Amer. Mus. Nov., 1140:2.

Holotype.—RMNH "cat. a, v. sp. a," female; from Ambon Island, Moluccas, Indonesia.

Measurements of holotype.—Length of forearm, 39.3; condylocanine length, 12.5; zygomatic breadth, 7.1; width of postorbital constriction, 1.7; mastoidal breadth, 6.7; alveolar length of maxillary toothrow, 4.9; and breadth of palate at M^3–M^3, 5.2.

Distribution.—Known from the Moluccan islands of Morotai, Batjan, Buru, Ambon, Seram, Gorong, and Kai.

Diagnosis.—Externally and cranially small-sized for the species (Tables 2, 3); forearm averaging small; cranially small, interorbital and mastoidal region narrow, breadth of palate narrow, and skull short; maxillary toothrow long relative to skull length in males.

Specimens examined (29).—Indonesia: Moluccas, Buru Island, Leksoela, 4 (4 BMNH); Batjan Island, 6 (6 BMNH); Ambon, 1 (1 RMNH, holotype); Seram, 14 (7 BMNH, 7 ZMA); Gorong Islands, 1 (1 BMNH); Kai Islands, 3 (3 BMNH).

Additional records.—Indonesia: Moluccas, Buru Island, Mefa; Leksula (Dammerman, 1929:161). Indonesia: Moluccas, Kai Islands (Peters and Doria, 1880:692).

Remarks.—Dobson (1878*c*:132) reports *Aselliscus tricuspidatus* from Morty Island [=Morotai Island] from the Halmahera group in the northern Molucca Islands. Dobson's specimen is a spirit-preserved, unregistered specimen in a poor state of preservation in the collection of the British Museum (Natural History). Such measurements as could be taken are as follows: length of forearm, 38.5; zygomatic width, 6.8; postorbital constriction, 1.7; length of the maxillary toothrow, 5.1; and breadth of palate at M^3–M^3, 4.9. The sex of the specimen could not be established. It is referred to the nominate subspecies.

Aselliscus tricuspidatus novehebridensis Sanborn and Nicholson, 1950

1950. *Aselliscus tricuspidatus novehebridensis* Sanborn and Nicholson, Fieldiana Zool., 31:331.

Holotype.—FMNH 55219, male; from cave on Segond Channel, Espiritu Santo Island, New Hebrides.

Measurements of holotype.—Total length, 60; length of tail, 20; length of hindfoot, 7; length of ear, 12; length of forearm, 41.5; condylocanine length, 13.5; zygomatic breadth, 8.0; width of postorbital constriction, 1.7; mastoidal breadth, 7.0; alveolar length of maxillary toothrow, 5.2; and breadth of palate at M^3–M^3, 5.5.

Distribution.—Known from the islands of Espiritu Santo, Aore, and Malekula.

Diagnosis.—Externally and cranially large-sized for species; length of forearm long; condylocanine length of skull long; palate and zygoma broad.

Specimens examined (2).—Espiritu Santo Island, New Hebrides, 2 (2 FMNH, including holotype).

Additional records.—New Hebrides: Aore Island, Aouta; Aore Island, Aouta Plantation; Espiritu Santo Island, Hog Harbor; and Malekula Island, Senwar Cave, Tenmial, northwest coast of island (Hill, 1983:151).

Remarks.—Hill (1983:151–152) reports 34 additional specimens of this subspecies from three islands in the New Hebrides and also gives measurements. Based upon this new material, it is evident that *A. t. novehebridensis* is larger than was indicated by the description, with forearm length reaching 43.5 in females and 42.2 in males in this new material.

Aselliscus tricuspidatus koopmani, new subspecies

Holotype.—Adult female, skin and skull, AMNH 159400; Liluta, 10 m, Kiriwina Island, Papua New Guinea, obtained on 15 December 1956 by R. F. Peterson, original number 14,977, on the Fifth Archbold Expedition to New Guinea.

Measurements of holotype.—Total length, 58; length of tail, 19; length of hindfoot, 7; length of forearm, 40.4; condylocanine length, 12.4; zygomatic breadth, 7.1; width of postorbital constriction, 2.0; mastoidal breadth, 6.7; alveolar length of maxillary toothrow, 4.9; and breadth of palate at M^3–M^3, 4.9.

Distribution.—Known from New Ireland and New Britain islands in the Bismarck Archipelago, Louisiade Archipelago, Trobriand Islands, Woodlark Island, and Solomon Islands to Santa Cruz Island.

Diagnosis.—Externally and cranially small for species; length of forearm short; skull short and narrow, with relatively broad interorbital region relative to skull size.

Comparisons.—*Aselliscus tricuspidatus koopmani* can be distinguished from the adjacent subspecies of the species (see Fig. 3) by its smaller size, both externally and cranially.

Etymology.—This new subspecies is named for Karl F. Koopman, Curator of Mammals, American Museum of Natural History, New York, in recognition of his keen interest in Australasian bats and for first mentioning (Koopman, 1982:17) the small size of specimens included in this new subspecies.

Specimens examined (138).—Papua New Guinea: New Ireland, no specific locality, 1 (1 BMNH); Papua New Guinea: Woodlark Island, Kulumadau, 200 m, 52 (52 AMNH);

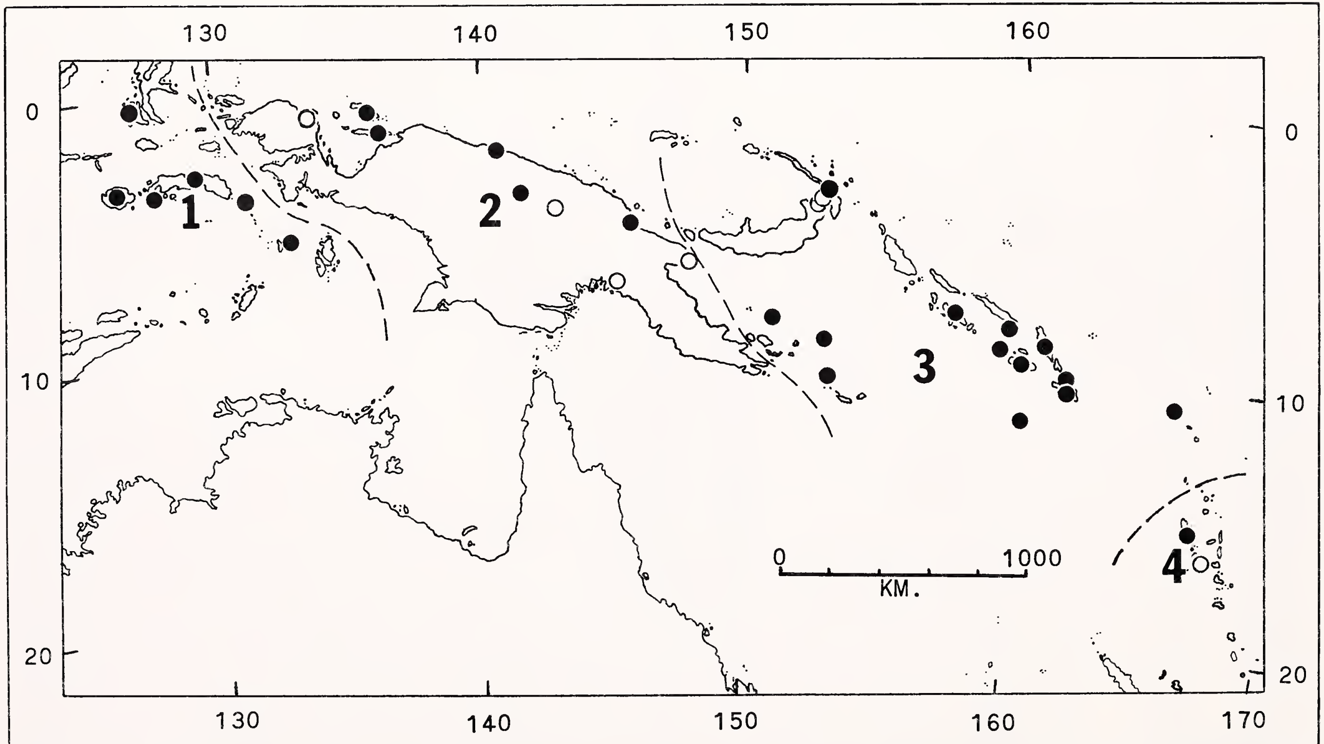

Fig. 3.—Geographic distribution of subspecies of *Aselliscus tricuspidatus*: 1) *A. t. tricuspidatus*; 2) *A. t. novaeguineae*; 3) *A. t. koopmani*; and 4) *A. t. novehebridensis*. Closed circles represent localities of specimens examined and open circles represent localities of additional records from the literature. The record from Morotai Island (Dobson, 1878*c*:132) is just off of the map at 2°10′N, 128°30′E in the northern Molucca Islands.

Papua New Guinea: Woodlark Island, no specific locality, 1 (1 BMNH); Papua New Guinea: Louisiade Archipelago, Misima Island, Kulumalia Mine, 150 m, 32 (32 AMNH); Papua New Guinea; Trobriand Islands, Kiriwina Island, Liluta, 3 (3 AMNH, including holotype); Solomon Islands: New Georgia Island, Munda Point, 8 (8 FMNH); Solomon Islands: New Georgia Island, no specific locality, 1 (1 BMNH); Solomon Islands: San Jorge Island, Talise, 1 (1 BMNH); Solomon Islands: Russell Islands, Banika Island, 1 (1 FMNH); Solomon Islands: Malaita Island, Riba Caves, near King George V School, Auki, 1 (1 BMNH); Solomon Islands: Guadalcanal, Aola, 2 (2 BMNH); Solomon Islands: Rennell Island, Tigoa, 4 (4 BMNH); Solomon Islands: San Cristobal, Warihito River—Goge River confluence, about 6 mi inland from Wainoni Bay, 27 (27 BMNH); Solomon Islands: Uki Ni Masi, 1 (1 FMNH); Santa Cruz Islands: Santa Cruz Island, 3 (3 AMNH).

Additional records.—Solomon Islands: Rennell Island, Kogoata Cave, Tigoa; Niupani (Hill, 1968:56). Papua New Guinea: New Ireland Province, near Sohun (Smith and Hood, 1981:108). Papua New Guinea: East New Britain Province, near Gunanur Plantation (Smith and Hood, 1981:108). Papua New Guinea: East New Britain Province, Duke of York Island (Dobson, 1877:121; 1878*a*:317).

Remarks.—The specimens from Santa Cruz Island and Uki Ni Masi [=Ugi Island] were originally reported by Sanborn (1931:24) as *Hipposiderus tricuspidatus.*

Specimens from New Ireland and New Britain islands are assigned to this new subspecies based upon the individual examined from New Ireland and the measurements reported by Smith and Hood (1981: 107). Variation in larger samples from these two major islands should be checked further to verify the subspecies to which they actually belong.

Aselliscus tricuspidatus novaeguineae, new subspecies

Holotype.—Adult female, skin and skull, CM 63498; Ama, 140 m, East Sepik Province, Papua New Guinea (04°09′S, 141°41′E), obtained on 9 March 1980 by Stephen L. Williams, original number 5089, Bernice P. Bishop—New Guinea field series BBM-NG 107652.

Measurements of holotype.—Total length, 71; length of tail, 25; length of hindfoot, 8; length of ear, 15; length of forearm, 41.3; condylocanine length, 13.5; zygomatic breadth, 8.0; width of postorbital constriction, 2.2; mastoidal breadth, 7.3; alveolar length of maxillary toothrow, 5.0; and breadth of palate at M^3–M^3, 5.4.

Distribution.—New Guinea and adjacent islands of Misor and Yapen in Irian Jaya.

Diagnosis.—Externally and cranially medium- to large-sized for species; length of forearm long; skull long and broad, condylocanine length long, and palate and zygoma broad.

Etymology.—This new subspecies is named for the island of New Guinea.

Specimens examined (42).—Irian Jaya, Schouten Islands, Misor Island, Korido, 1 (1 BMNH); Irian Jaya, Geelvink Bay District, Yapen Island, 1 mi NW Sumberbaba, 1000 ft, 2 (2 AMNH); Irian Jaya, Yapen Island, Dawai River, 1 (1 AMNH); Irian Jaya, Jayapura, 25 (20 AMNH, 3 USNM, 1 MVZ, 1 FMNH); Irian Jaya, South side Humboldt Bay, 4 (4 RMNH); Papua New Guinea: West Sepik Province, Kaiseren Augusta River

(4°4′18″S, 141°7′15″E), 1 (1 RMNH); Papua New Guinea: East Sepik Province, Ama, 140 m, 2 (1 CM, 1 PNGM, including holotype and BBM-NG 105921 to be deposited in PNGM); Papua New Guinea: Madang Province, Sempi, 13 mi N Madang, 4 (4 MVZ); Papua New Guinea: Madang Province, Sempi Cave, 13.5 mi N, 1.5 mi W Madang, 1 (1 MVZ); Papua New Guinea: Madang Province, South Banup Cave, 6.5 mi S, 4.5 mi W Madang, 1 (1 MVZ).

Additional records.—New Guinea: no specific locality (Dobson, 1878*b*:876). Papua New Guinea: Madang Province, 8 km E Baku, Gogol Valley, (Hill, 1983:152). Papua New Guinea: Morobe Province, Huon Peninsula, no specific locality (Koopman, 1982: 16, [=Finschhafen, Koopman, *in lit.*]). Papua New Guinea: Gulf Province, Putei (McKean, 1972:27). Papua New Guinea: East Sepik Province, Wagu (McKean, 1972:27). Indonesia: Irian Jaya, Andai (Peters and Doria, 1880:692).

Remarks.—The two females from Ama were mist-netted in forest on 9 March 1980. Neither contained embryos although the holotype was lactating. Each weighed 4 g. A male (MVZ 138607) from Sempi Cave, Papua New Guinea, had testes measuring 3.5 mm in length and 1.5 mm in width when captured on 1 August 1969. A female (MVZ 138605) from Sempi had no embryos when checked on 24 July 1969. A male (MVZ 138603) from South Banup Cave, 6.5 mi S, 4.5 mi W Madang, Papua New Guinea, had testes measuring 3 by 2 mm when captured on 25 August 1969. The record from Putei reported by McKean (1972: 27) is the only report of this species from the southern portion of New Guinea. Additional collecting by mist-netting as well as visiting caves should result in specimens from elsewhere in the region, especially in Irian Jaya.

ACKNOWLEDGMENTS

Specimens were examined from the following museum collections; acronyms used in the text are listed with each collection. We are indebted to the persons listed with the collections for allowing us to study specimens in their collections. American Museum of Natural History (AMNH), New York, Karl F. Koopman; British Museum, Natural History (BMNH), London; Carnegie Museum of Natural History (CM), Pittsburgh; Field Museum of Natural History (FMNH), Chicago, Robert Timm and Bruce Patterson; Museum of Vertebrate Zoology, University of California (MVZ), Berkeley, James L. Patton; National Museum of Natural History, Smithsonian Institution (USNM), Washington, D.C., Charles O. Handley, Jr., and Michael Carleton; Papua New Guinea National Museum and Art Gallery (PNGM), Port Moresby, Simon Poraituk and Paul Banguinan; Rijksmuseum van Natuurlijke Histoire (RMNH), Leiden, Chris Smeenk; and Zoological Museum (ZMA), Amsterdam, Peter van Bree.

The field work in Papua New Guinea which resulted in this contribution was part of a joint Carnegie Museum of Natural History, University of Maryland School of Medicine, Bishop Museum, Wau Ecology Institute, and Papua New Guinea National Museum and Art Gallery expedition. Financial support came, in part, from the M. Graham Netting Research Fund, Carnegie Museum of Natural History, established by a grant from the Cordelia S. May Charitable Trust, and Grant AI-04242 from the National Institutes of Health, Washington, D.C., to the Department of Microbiology, University of Maryland School of Medicine, Baltimore, MD.

Financial and logistical support for the field work was made available by the following individuals and institutions: Robert Traub, University of Maryland School of Medicine, Baltimore; Frank J. Radovsky, Alan C. Ziegler, and the late J. Linsley Gressitt (also then

Director, Wau Ecology Institute) of the Bernice P. Bishop Museum, Honolulu; Harry Sakulas and Allen Allison of the Wau Ecology Institute, Wau, Papua New Guinea; and Simon Poraituk and Paul Banguinan of the Papua New Guinea National Museum and Art Gallery, Port Moresby. Assistance in the field was supplied by Paul Wanga of the Papua New Guinea National Museum and Art Gallery and Abid Beg Mirza and Gari Binyuo of the Wau Ecology Institute. Permission to conduct research in Papua New Guinea was received from the Institute of Papua New Guinea Studies. Permits were obtained from Mick Raga, Wildlife Division, Office of Environment and Conservation, Port Moresby. We are grateful to all of these persons and institutions.

Alan C. Ziegler, Frank S. Radovsky, and Robert Traub reviewed an early draft of the manuscript; we thank them for doing so.

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